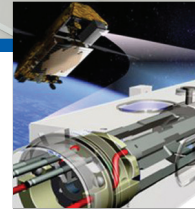
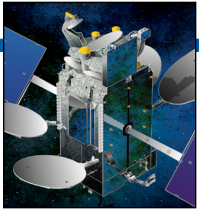


Technology Demonstration Mission Program

The Bridge

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NASA's Supersonic Decelerator Craft Ready for Flight Test

NASA's [Low-Density Supersonic Decelerator](#) (LDSD) project, a rocket-powered, saucer-shaped test vehicle, awaits flight testing after completing final assembly in May at the U.S. Navy's Pacific Missile Range Facility in Kauai, Hawaii. Inclement weather caused a scheduled flight test in June to be scrubbed; at press time, a new launch window had yet to be announced.

This experimental flight test is designed to investigate breakthrough technologies that will benefit future Mars missions, including those

involving human exploration. Weeks of testing, simulations and rehearsals were conducted prior to the pending launch opportunity.

LDSD was built at NASA's [Jet Propulsion Laboratory](#) in Pasadena, California, and shipped to Kauai for final assembly and preparations.

During the experimental flight test, a balloon will carry the test vehicle from the Hawaii Navy facility to an altitude of about 120,000 feet. There, it will be dropped and its booster rocket will quickly kick in and carry it to 180,000

The Low-Density Supersonic Decelerator test vehicle, seen here in the Missile Assembly Building at the U.S. Navy's Pacific Missile Range Facility in Kauai, Hawaii. (Image: NASA/JPL-Caltech)

feet, accelerating to Mach 4. Once in the very rarified air high above the Pacific, the test vehicle will begin a series of automated tests of two breakthrough technologies.

In order to get larger payloads to Mars, and to pave the way for future human explorers, cutting-edge technologies such as LDSD are critical. Among other applications, this new space technology will enable delivery of the supplies and materials needed for long-duration missions to the Red Planet.

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Critical Engine Technology Validates Green Propellant Mission Advantages

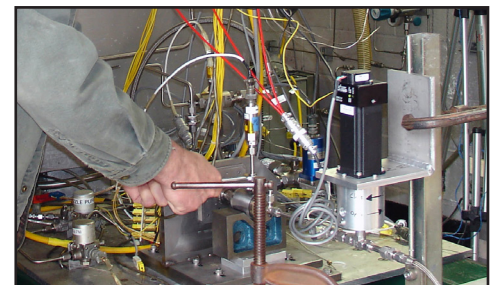
The [Green Propellant Infusion Mission](#) (GPIM) has exceeded the thruster operating range objective for the main thruster set to fly on the GPIM spacecraft in 2015.

The GPIM team demonstrated that the 22 Newton-class thruster, running the "green" propellant known as AF-M135E propellant, had an operating range greater than that of traditional hydrazine propellant used in spacecraft.

The test, conducted in a lab environment, continuously demonstrated that the thruster had enough force to go as high as 27 Newtons and scale down to 4 Newtons.

During flight, the 22 Newton thruster will fire simultaneously with four smaller, 1 Newton thrusters to initiate the GPIM satellite's orbit inclination and altitude changes.

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Aerojet Rocketdyne mechanical test technician sets up the thruster for flow testing in preparation for the 22N firing test. (Ball Aerospace)

Cryogenic Propellant Project Changes Direction, Name

Earlier this year, the [Space Technology Mission Directorate](#) (STMD) directed the [Cryogenic Propellant Storage and Transfer](#) (CPST) project to reformulate from a spaceflight technology demonstration project to a ground technology demonstration project based on the directorate's budget environment and the [Space Launch System's](#) need for quicker, near-term infusion of key technologies.

This spring, the project — managed by NASA's [Glenn Research Center](#) — submitted a plan to reflect the new direction. The new project, now known as “eCryo,” or Evolvable Cryogenics, has been approved by STMD.

The new name was created by Melanie Dervan, a liquid propulsion systems engineer at NASA's [Marshall Space](#)

[Flight Center](#), which manages the [Technology Demonstration Missions Program](#) for the agency.

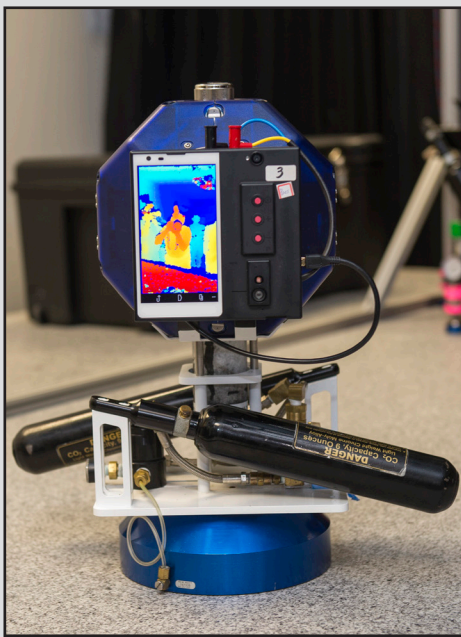
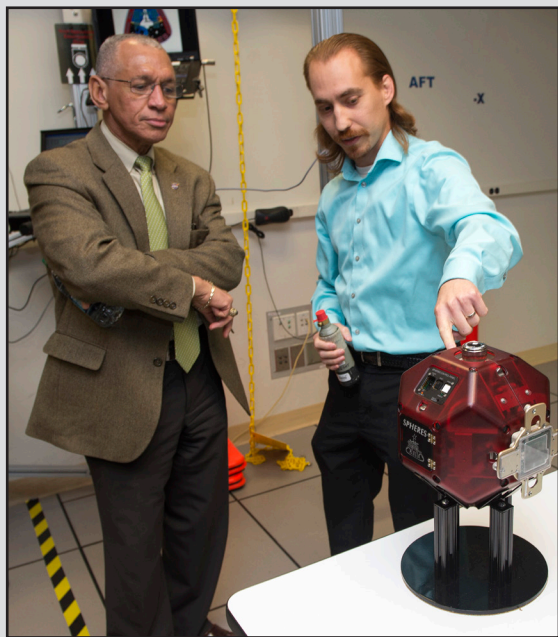
The eCryo formulation team currently is gathering data for potential technical content. Tasks are being formulated for cryogenic fluid management technologies that will support development of the Space Launch System and make use of large-scale systems to assess performance of numerous technologies such as vapor cooling, multilayer insulation, gauging and analytical models. The eCryo project plan is scheduled to be completed this September.

The CPST project also has several tandem milestones to deliver in the remainder of fiscal year 2014, including hydrogen testing of the Engineering Development Unit; holding an industry

infusion workshop to demonstrate liquid oxygen zero boil-off; and organizing a meeting with the French space agency [Centre National d'Études Spatiales](#) to benchmark analytical models using shared data.

In addition to a change in name, the project also has undergone changes in management. Glenn engineers Carol Ginty and Hans Hansen have assumed the roles of eCryo project manager and deputy manager, respectively. Former CPST manager Susan Motil has taken on a new position at Glenn Research Center.

NASA Administrator Meets ‘SPHERES’



During a visit this spring to NASA's [Ames Research Center](#) in Moffett Field, California, NASA Administrator Charles Bolden toured the laboratory used for research on the [Human Exploration Telerobotics](#) project's volleyball-sized satellites called “Synchronized Position Hold, Engage, Reorient, Experimental Satellites,” or [SPHERES](#). At left, Ames engineer Jose Benavides shows Bolden the technology involved in the free-flying smallsats. At right, Bolden experiments with the controls for a SPHERES prototype unit. Currently in use aboard the International Space Station, SPHERES are used to conduct experiments in space robotics and spacecraft guidance navigation, control and docking. They provide opportunities to affordably test a wide range of hardware and software. (Image: NASA/ARC)

NASA Wows Science and Engineering Festival Crowds



At the Science and Engineering Festival held this spring in Washington, the [Technology Demonstration Missions Program](#) was among numerous NASA mission directorates, programs and projects sharing a 60-foot-by-60-foot exhibit booth — and bringing the latest NASA technology news to some 325,000 visitors at the second annual high-tech expo. Among the TDM projects on exhibit were the [Human Exploration Telerobotics](#) project and a new parachute display by the [Low Density Supersonic Decelerator](#) project. (Images: NASA/ARC)



Critical Engine Technology Validates Green Propellant Mission Advantages ...continued from p. 1

In the space environment, GPIM will demonstrate how AF-M315E can replace the highly toxic hydrazine and complex bi-propellant systems in use today. AF-M315E is a hydroxyl ammonium nitrate fuel/oxidizer blend, originally developed by the U.S. Air Force Research Laboratory at Edwards Air Force Base, California. It is expected to significantly enhance propulsion performance in space.

The new propellant technology will raise both the 22 Newton-class and 1 Newton-class AF-M315E thruster readiness for flight, enabling safer and less costly space missions.

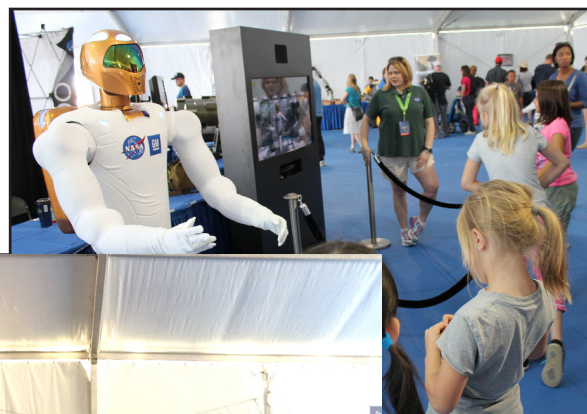
The GPIM team is led by [Ball Aerospace & Technologies Corp.](#) of Boulder, Colorado, which also is providing the GPIM spacecraft bus. [Aerojet Rocketdyne](#) of Sacramento, California, has developed the thruster

and catalyst technologies which enable practical applications for space missions. Government partners include NASA's [Glenn Research Center](#) in Cleveland, Ohio; NASA's [Goddard Space Flight Center](#) in Greenbelt, Maryland; NASA's [Kennedy Space Center](#), Florida; and the [U.S. Air Force Research Laboratory](#), with additional mission support from the [Air Force Space and Missile Systems Center](#) at Kirtland Air Force Base, New Mexico.

http://www.nasa.gov/mission_pages/tdm/main

“Robot Rocket Rally” Draws Visitors to Kennedy Space Center

This spring, NASA’s [Technology Demonstration Missions Program](#) debuted a versatile new addition to [Robonaut 2: dexterous, multi-capable new legs](#). Members of the [Human Exploration Telerobotics](#) project, which oversees “R2,” were part of a three-day “Robot Rocket Rally” held at NASA’s [Kennedy Space Center](#), Florida, where they demonstrated R2’s new legs for members of the public and key stakeholders. The [Space Technology Mission Directorate](#) exhibit included the R2 torso model as well, plus an Xbox-based [Kinect training game](#). Along with NASA, 10 other robotics groups participated in the rally. (Images: NASA/KSC)



NASA’s Supersonic Decelerator Craft Ready for Flight Test ...continued from p. 1

Anyone with Internet access will be able to watch the test live as onboard video is relayed to the ground. The low-resolution images from the test vehicle are expected to show the vehicle dropping away from its high-altitude balloon “mothership” and then rocketing up to the very edge of the stratosphere. The test vehicle then will deploy an inflatable Kevlar tube around itself, called the Supersonic Inflatable Aerodynamic Decelerator. After it inflates, the vehicle will deploy a mammoth parachute called the Supersonic Disk Sail Parachute.

“This first test is a true experimental flight test,” said Ian Clark, principal investigator for LDSD at JPL. “Our goal is to get this first-of-its-kind test vehicle to operate correctly at very high speeds and very high altitudes.”

Regardless of the outcome, the LDSD team expects to learn a great deal from the test. NASA has two more saucer-shaped test vehicles in the pipeline, with plans to test them from Hawaii in summer of 2015.

“We are pushing the envelope on what we know,” Clark said. “We will

learn a great deal even if these tests, conducted here in Earth’s atmosphere at relatively low cost, fail to meet some of the mission objectives.”

As NASA plans increasingly ambitious robotic missions to Mars, laying the groundwork for even more complex human science expeditions to come, the spacecraft needed to land safely on the Red Planet’s surface will become larger and heavier. This new technology will enable those important missions.

Read more about the project, the upcoming test and more in [an interview with Carole McLemore](#), LDSD mission manager at NASA’s [Marshall Space Flight Center](#) in Huntsville, Alabama.

NASA’s [Space Technology Mission Directorate](#) in Washington funds the Low-Density Supersonic Decelerator mission. The Marshall Center manages the [Technology Demonstration Missions Program](#), including LDSD, for the agency. NASA’s [Wallops Flight Facility](#) on Wallops Island, Virginia, coordinates support with the Pacific Missile Range Facility and provided the balloon systems for the LDSD test.

Initially reported by David Agle, a media relations specialist at NASA’s Jet Propulsion Laboratory.



The experimental flight vehicle is prepared for a range compatibility test at the Pacific Missile Range Facility. (Image: NASA/JPL-Caltech)



Editor's Note: TDM Bridge Builders are team members at NASA centers and partner organizations who are helping bridge the gap, bringing one or more of our cutting-edge TDM technologies to flight readiness. Know a team member worthy of a place in the limelight? Email richard.l.smith@nasa.gov.

As the Low-Density Supersonic Decelerator (LDSD) team busily prepared for early June flight testing (see lead story), we caught up briefly with NASA systems engineer Ian Clark of NASA's Jet Propulsion Laboratory in Pasadena, California, to discuss this exciting TDM project. As LDSD principal investigator, he spared us what time he had!

How do you hope the Supersonic Decelerator project will impact NASA's TDM goals?

For the first time in more than four decades, NASA is testing full-scale supersonic decelerators at Mach numbers and environments analogous to what they would face at Mars. We're doing this because we have maxed out the landing capabilities of the technologies we've relied on for the past four decades of Mars missions. When LDSD completes its objectives, we will have matured a set of decelerators that will be used for decades of Mars missions — missions that will include even more capable robotic explorers and precursor missions for putting humans on Mars.

What's the payoff you're most excited to see?

When I was in college and grad school, I would often go into the NASA Technical Report Archives to dig up old reports on the technologies and testing that occurred in the early days of the agency. I tended to learn more from those reports than from some of my textbooks, because they were very applied and were written by folks who were, in a sense, "discovering" the science of aerospace engineering and how to explore space and our solar system. Much of what we've done since then in the field of supersonic decelerators has leveraged that early work. With LDSD, however,

I believe we are once again on the forefront of understanding how these decelerators behave, how to build them more efficiently and how we can grow them to enable ever-more-challenging missions. That to me is the most exciting part — being back on the cutting edge of aerospace engineering, and working on technologies that will be used for quite some time.

When did you join NASA? What was your first job for the agency?

My first NASA job was as an intern with Lockheed Martin at the [Johnson Space Center](#), where I worked on processing hardware for the space shuttle and the International Space Station. Later, I interned at both the [Langley Research Center](#) and the [Ames Research Center](#), working on supersonic wind tunnel testing of deployable decelerators. I joined NASA and the Jet Propulsion Laboratory full-time in July 2009. My first task was working on a study for future vehicle entry, descent and landing technologies.

What's one thing most people would be surprised to learn about you?

Probably my music tastes; I'm a bit of a fan of European folk metal. I've managed to drag my wife to a number of concerts. Perhaps more surprising — to me anyway — was having to persuade her not to venture into the mosh pits.



Ian Clark, principal investigator for the LDSD project, talks to NASA Edge about his team's revolutionary Technology Demonstrator Mission. (Image: NASA EDGE)

Looking Ahead: Projects on the Move

From the TDM Program Manager

By John McDougal



McDougal manages the TDM Program Office at the Marshall Center.

One of the best things about working in this program is seeing cutting-edge technologies come to life. The [Technology Demonstration Missions Program](#) provides NASA the opportunity to develop low-cost, risk-tolerant technologies that can change the way we explore our solar system.

One of these technologies is the [Low-Density Supersonic Decelerator](#) (LDSD) project. NASA's plans are bold and include sending humans one day to Mars. To do that, we've got to have a plan to deliver to the surface the cargo and supplies our people will need there. LDSD, as you've read elsewhere in this issue of "The Bridge," is the first step in designing new ways to decelerate large payloads, and I'm proud of the team and the progress they've made in getting this project to its latest crucial test phase. This test is risky like any

other. It may not turn out exactly like we want it to. But that's why we test — to determine what works and what doesn't, and how we can make the technology better.

We have a busy year ahead of us as several of our projects are entering important development phases. The [Green Propellant Infusion Mission](#) (GPIM) is overcoming manufacturing hurdles to get the 1 Newton thruster ready for hot-fire testing — a significant accomplishment to maintain that project's schedule. The [Deep Space Atomic Clock](#) (DSAC) project is moving steadily ahead, gearing up for the STP-2 launch in the second quarter of fiscal year 2016. We're addressing management challenges with the [Solar Sail Demonstrator](#) (SSD) and funding challenges with the [Cryogenic Propellant Storage and Transfer](#) (CPST) projects which

resulted in ground demonstrations, with helpful lessons learned adding overall value and benefit to [Space Technology Mission Directorate](#) and the TDM project family.

And finally, we're already looking forward to the TDM Program's annual review, set for October, and we'll be working with all the projects to get a good data call.

Onward!

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